Description

Web server comprising integrated automation functionality

5   The invention relates to a web server comprising software
modules which are integrated into the web server and an
automation system or, as the case may be, a computer program
product comprising a web server of said type.

10  Servers that are linked via the internet to clients and make
information, typically internet pages, available to these
clients are called web servers. A web server of said kind is
an application which runs on a single computer or in a
distributed manner on a plurality of computers. The web server
15  provides centralized storage for data which can be used by
many different clients, regardless of the particular location
of a client. The term "web server" is used to describe both
the software application executing on a computer and also the
computer itself. Web servers are nowadays used as a general-
20  purpose means of delivering information in the internet, but
also in local area networks which are based on internet
technologies. In this arrangement use is often made of the
possibility of extending the web servers with expansion
modules, for example in order to enable access to databases,
25  forms, etc. The communication between client and web server
usually takes place in accordance with the HTTP protocol
(HTTP= Hyper Text Transfer Protocol).

US 6 061 603 A describes a control system which allows a user
30  to access a programmable logic controller over a communication
network such as, for example, the Internet using a web
browser. The system includes an interface between the network
and the programmable logic controller. This web interface, as
it is called, provides internet pages from an Ethernet
35  interface of the programmable logic controller and includes an
HTTP protocol interpreter and a TCP/IP stack (TCP/IP =

2

Transmission Control Protocol/Internet Protocol). The web
interface thus offers a remote user access to the programmable
logic controller via the internet.

5    The object of the invention is to disclose a possible non-
proprietary solution for implementing an automation
functionality.

This object is achieved by means of a web server comprising
10   software modules in which at least a first software module has
first means for implementing an automation functionality.

The invention is based on the knowledge that at the present
time the conventional automation world has few points of
15   contact with the internet due to the fact that in automation
technology use is made predominantly of proprietary protocols.
This notwithstanding, the development of web technology is
advancing apace without issues relating to automation
technology being taken into account. Previous approaches to
20   integrating dedicated web server functionality into the
automation components are in turn based on proprietary
solutions for the individual components. Moreover, the
performance of solutions of said kind revealed itself to be
very limited. The web server according to the invention
25   combines web technology with automation technology in an
unexpected manner, in that an expansion module, typically a
software module, which is integrated directly in the web
server provides the required automation functionality. A web
server whose functionality is extended in such a way is
30   capable of processing not only complex tasks of conventional
automation technology but also applications on a smaller
scale, for example in the consumer domain. The direct
integration of the automation functionality into the web
server means that existing web implementations can also be
35   used in the processing of the automation function.

As a result of the connection of the web server according to
the invention to a communication network, in particular the
internet, on the one hand internet technologies are made
accessible to automation technology and on the other hand an
5    end-to-end connection of the automation components to the
communication network or, as the case may be, the internet is
achieved.

The use of internet protocols for communication between the
10   software modules themselves and for communication between the
software modules and components located outside of the web
server enables the standardization of the components of the
web server with regard to their communication interfaces.
Expansion of the web server with further modules is
15   facilitated, since said modules can be used without complex
and time-intensive adaptation to proprietary protocols.
Example of typical internet protocols are HTTP and FTP (File
Transfer Protocol).

20   In an advantageous embodiment of the invention the web server
is provided for the configuration and administration of the
software modules.

The web server according to the invention is easily scalable
25   and so can be used, according to a further advantageous
embodiment, for controlling the components of an industrial
automation system if the first software module has a
connection to the industrial automation system.

30   In order to use available internet security mechanisms it is
proposed that the web server has a connection to the internet
via a firewall. In the case of the already typical web server
expansions integrated into an automation component, the
security mechanisms required in the internet usually cannot be
35   implemented because of the limited scope for modification.

4

The connection of the web server to a communication network, in particular the internet, can be advantageously used to support the automation functionality if the web server is linked via a communication network to a web browser as the
5    control and monitoring system for the automation system controlled by the first software module. This control and monitoring system can also be used for project planning, for configuration, for programming, and for rolling out software updates, in other words generally for data communication and
10   data representation.

In order to enable web technologies to be used also for real-time applications it is proposed that the web server has a real-time operating system. In particular when deployed in
15   process automation, the automation components used must have real-time capability. This requirement can be met by coupling of the first software module to the real-time operating system. The real-time operating system can be used in addition to a non-real-time-capable operating system (part) or as a
20   standalone operating system.

The invention will be described and explained in more detail below with reference to the exemplary embodiments represented in the figures, in which:
25

FIG 1    shows a system comprising web servers which are
         interconnected via the internet and fulfill different
         tasks,

FIG 2    shows a web server comprising automation
30           functionality, and

FIG 3    shows a schematic view of the structure of a web
         server comprising automation functionality.

FIG 1 shows different web servers 3, 10, 15, 20, 24 which are
35   connected to one another directly or indirectly via the
     internet 1. A first web server 3 communicates directly with

the internet 1 via a connection 2. The first web server 3
includes an expansion module 4 which is connected via a
connection 5 to an input/output module 6 of an automation
system. A second and a third web server 10, 15 are connected
5   to the internet 1 via connections 9, 14, a firewall 8 and a
connection 7. The second web server 10 has an expansion module
11 which has a connection 12 to a converter 13. The third web
server 15 includes an expansion module 16 which controls a
drive 18 via a connection 17. The reference numeral 20
10  identifies a fourth web server, referred to as an embedded web
server, which is connected directly to the internet 1 via a
connection 19 and has an expansion module 21 which controls a
valve 22. The fifth web server 24 shown in FIG 1 possesses no
automation functionality whatsoever and communicates with the
15  internet via a connection 23. A web browser 26 is connected to
the internet 1 via a connection 25.

The idea on which the invention is based will be explained
below with reference to FIG 1. A web server is a process
20  running on a computer - or also distributed over a plurality
of computers - and typically supplies very many clients (web
browsers on different devices) with information. This
information can either reside statically on the web server or
else be generated dynamically by further utility routines.
25  Typical communication partners connected via the internet 1
are therefore web servers in the embodiment of the fifth web
server 24 and web browser 26. The fifth web server 24 provides
information, generally internet pages, via the internet 1 in
response to a request from a web browser 26. The idea of the
30  invention is thus to configure a standard web server of this
type through expansion by means of software modules in such a
way that it can also solve automation tasks. The first web
server 3 includes an expansion module 4 which takes on the
functions of a programmable logic controller (PLC). Toward
35  that end, the expansion module 4 as part of the web server 3
is additionally connected to an input/output module of an

6

automation system by means of a connection 5. The first web
server 3 therefore serves not only to deliver information into
the internet 1 via the connection 2, but can also, thanks to
the integration of the expansion module 4, execute complex

5    control tasks which in the prior art were previously only
executable by means of independent programmable logic
controllers. A further exemplary embodiment of the web server
according to the invention is shown in FIG 1 in the second web
server 10 which has an expansion module 11 comprising CNC (CNC

10   = Computer Numerical Control) functionality. Via the expansion
module 11, the second web server 10 controls a computer-
controlled machine tool 13 (CNC machine tool) which is used
for fast and precise production of complex turned and milled
parts. Complex controls of said kind are usually executed by

15   computers specified explicitly for that purpose. The control
of a drive 18 which is handled by the third web server 15 in
the exemplary embodiment reveals itself as a similarly complex
control task. For this purpose the third web server 15
includes an expansion module 16 which assumes the demanding

20   tasks of controlling and/or regulating the drive 18. In order
not to pay for the advantages of using web technologies by the
second and the third web server 10, 15 at the expense of the
disadvantage of absence of security, the web servers 10, 15
are linked to the internet 1 via a firewall 8. The firewall 8

25   effectively prevents illegal accesses via a communication
connection 7 to one of the web servers and therefore to the
drive 18 or the machine tool 13. In a further exemplary
embodiment of the invention shown in FIG 1, the web server
comprising automation functionality is what is known as an

30   embedded web server 20 which includes, in the form of
expansion module 21, a temperature controller for controlling
a valve 22. This embedded web server 20 is implemented for
example as a single-chip solution within a personal computer
(PC). In addition to the automation functionality of the

35   expansion modules, each of the described web servers 3, 10, 15
and 20 also provides all the functionalities and therefore all

the advantages of a standard web server 24. Thus, the web
browser 26 connected via the internet 1 can also make use of
web technologies to access the web servers 3, 10, 15 and 20
that have been extended with automation functionality and so

5   be used, for example, as a control and monitoring system. The
exemplary embodiments illustrated in FIG 1 clearly show the
better scalability of the solution proposed here in
contradistinction to traditional approaches. The web server
can be embodied as a single-chip web server with hardware add-

10  on (e.g. in the consumer domain) right through to a high-
performance web server featuring SoftPLC and Office software.

FIG 2 shows an exemplary embodiment of a web server comprising
automation functionality in a schematic view. A web server 33

15  is connected via a connection 32 and a TCP/IP stack 31 to a
TCP/IP connection 30. The web server 33 includes a first
expansion module 34 which is embodied as a database module and
has access by means of a connection 35 to a SQL7 server 36
(SQL = Structured Query Language). A second expansion module

20  37 possesses automation functionality and communicates via a
connection 38 with an industrial process 39. The expansion
module 37, a software module, is coupled via an interface (not
shown in the figure) to the connection 38 and therefore to the
hardware components of the automation system for controlling

25  the industrial process 39. As front-end software, the TCP/IP
stack controls the accesses to a network card (not shown in
the figure) which has access to the TCP/IP connection 30 and
makes the TCP/IP protocol available to the accessing
processes.

30

FIG 3 shows the schematic view of the structure of a further
exemplary embodiment of a web server comprising automation
functionality. Software components of the web server are
depicted. An operating system 50 of the computer on which the

35  web server runs includes a standard operating system 51 as
well as a real-time operating system 52. A web server kernel

8

54 is superimposed on top of the underlying operating system
50 using the intermediary of a porting 53. The web server
kernel 54 provides standardized interfaces for coupling the
software components and forms the basis for various software
5       expansion modules. A first expansion module 55 serves to
provide web pages, while a second expansion module 56 serves
as an XML parser. A Profibus access 58 is connected by means
of a third expansion module 57. A fourth expansion module 59
provides Java functionality, while a fifth expansion module 60
10      processes signals of a webcam. A sixth expansion module 64
serves for processing XML data. A seventh expansion module 61
comprising automation functionality has a connection 62 to a
process and a connection 63 to an interface 65 to the real-
time operating system 52. A system is regarded as real-time-
15      capable if it can react to random external events within a
specifiable and guaranteeable time. Reaction times in the
microsecond range are typical and essential in industrial
automation systems. Real-time processes can use all the
services which are also available to other processes.
20

The operating system 50 has direct access to the resources of
the computer, such as, for example, memory and computing time.
When a command is sent off or a program invoked, the required
program code is loaded into a main memory and started as a
25      process. Processes have no access to the resources, but
request these from the operating system in each case.
The direct integration of the automation functionality into
the web server in the form of the seventh expansion module 61
makes the performance, services (e.g. autotopology, SSDP,
30      SNMP, e-mail etc.) and the openness of the internet accessible
to the automation world and enables the additional above-
described advantages to be achieved. The seventh expansion
module 61 on the one hand implements the automation solution
and on the other hand exchanges information via the web server
35      and is configured and administered by said web server. In
contrast to this, in the case of a so-called SoftPLC (=

. 9

software simulation of a programmable logic controller) the
automation function is not integrated into the server, but is
installed in parallel thereto, possibly connected via a
communication interface. Integration in the server means in
5    particular that an expansion module is loaded, configured,
started and terminated directly by the web server. An
expansion module of this kind is frequently referred to also
as an "extension". The web server kernel 54 of the web server
according to the invention serves as a common platform for the
10   expansion modules. This facilitates in particular the
configuration of the software expansion modules and their
reuse in other applications. The expansion modules are not
coupled by means of proprietary interfaces or interfaces which
have been programmed out, but are connected by means of
15   standardized interfaces, for example API (Application
Programming Interface) or CGI (Common Gateway Interface). API
is a formally defined interface via which application programs
can use system services (network, operating system, etc.) or
services of other application programs. CGI describes a
20   standard interface between a web server and programs. As means
for implementing an automation functionality, the seventh
expansion module 61 has regulation and/or control means for
regulating and/or controlling components and processes of an
automation system. Said regulation and control means for
25   controlling an automation system are typically embodied as
software processes which are executable in the expansion
module.

The proposed web server is part of a system of distributed
30   applications that is constructed on the basis of a client-
server architecture. In a system of this kind it is the task
of a server as the provider of a service to perform
calculations or other internal processes in response to
requests from a client and to formulate its results as
35   protocol-compliant answers and pass them on to the requesting
client. The term "client" in this case refers to a device or a

10

process which makes use of the service of one or more servers.
Usually, therefore, the server makes a service available
passively and waits for a client to submit a request to it.
The client, on the other hand, makes no services available but

5    instead avails itself of services provided by a server. A
server as the provider of a service can reside on the same
device as the client or on a different device which is
accessible via a network (for example the internet). The
client-server communication obeys certain rules and formal

10   descriptions, called protocols. It is an essential requirement
for successful communication between client and server that
both sides use the same protocol. Such a protocol typically
specifies the communication channels and the formats used for
login, information exchange, request, response and logoff. Not

15   all of these steps have to be specified explicitly in every
case if they are not relevant to the purpose of the
application. Protocols are specified at the most diverse
abstraction levels and normally build one on top of the other.
In that case the structure is referred to as a layer model

20   (e.g. the ISO/OSI layer model). Whereas the lowest layers
regulate the communication of hardware and devices –
electrical signals, cables or radio frequencies and their
characteristics are specified – the middle layers are
concerned with the building of network topologies (address

25   structures and their resolution, routing, and error
correction). In this case the network layer (e.g. IP =
Internet Protocol) is often separated from the transport layer
(e.g. TCP = Transmission Control Protocol). The topmost layers
are referred to as the application layer. At this level it is

30   specified how actual client-server applications communicate
with one another. Examples of such application layer protocols
are HTTP (Hyper Text Transfer Protocol), FTP (File Transfer
Protocol) and SMTP (Simple Mail Transfer Protocol).

35   In summary, the invention therefore relates to a web server
comprising software modules which are integrated into the web

server, in which web server at least a first software module
37 has first means for the non-proprietary implementation of
an automation functionality.